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SCHOOL OF AVIATION

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Contemporary Issues in Aviation

Education and Research

CONTENTS

Massey University School of Aviation & Aviation Industry Association of New Zealand – Inaugural Aviation Education and Research Conference

Contemporary issues in aviation education and research

Capt. Ashok Poduval

'Contemporary issues in aviation education and research' is the theme for the inaugural Aviation Education and Research Conference to be held in Blenheim on the 29-30 July as part of the New Zealand Aviation Conference week.

The conference is being organised by the Massey University School of Aviation in conjunction with the Aviation Industry Association of New Zealand.

"This event is intended as a forum for disseminating research and discussing current issues in aviation, with an emphasis on bridging theory and practice," says Mr Ashok Poduval, General Manager of the Massey University School of Aviation, "It will also present an opportunity for 'a meeting of the minds' for academics and practitioners in the aviation industry."

The two day conference has generated a lot of interest within New Zealand as well as in Australia and the wider international academic community, with many attendees and presenters crossing the Tasman to be part of this event.

"We are very pleased with the response," adds Dr Robert Yaansah, Postgraduate Programmes and Research Coordinator of Massey School of Aviation. "A wide range of papers have been received from academics, representing a good cross section of universities within the Australasia region. Additionally, a number of our PhD Aviation students are presenting papers related to their research. This conference should establish that the region has an academic community with a strong focus on aviation education and research, as good as elsewhere in the world."

Some of the papers accepted for presentation include:

Memes in Aviation - John Murray, Lecturer, Edith Cowan University, Australia

Patterns of Threat and Error in Regional Airlines - A/Prof Patrick Murray, Griffith University Aerospace Safety Centre, Australia

The Externalisation of Air Transport Reform in Europe: a Selective Analysis of the Developing Role of the European Commission - Prof Alan Williams, Massey University

Confirmation bias in general aviation lost procedures - Dr Andrew Gilbey & Dr Stephen Hill, Lecturers, Massey University

The further development of the bachelor of technology in aviation degree program at the Australian Defence Force Academy - Dr Raymond Lewis, Senior Lecturer, University College, Australian Defence Force Academy

A flight test laboratory for Aviation Education - Dr Michael Harrap & Dr Raymond Lewis, University College, Australian Defence Force Academy

Public/Private Risk Sharing in Air Service Provision - Associate Professor David Duval, University of Otago, New Zealand

For further information regarding this conference please visit the Massey University, School of Aviation website, contact the conference coordinator on 04 472 2707 or email info@aia.org.nz

AVIATION EDUCATION AND TRAINING

A Flight Test Laboratory for Aviation Education

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***Abstract**: This paper provides an overview of the Flight Test Laboratory Program at the School of Engineering and Information Technology at the Australian Defence Force Academy. This is an airborne laboratory in which undergraduate and postgraduate students investigate aircraft performance, handling qualities and stability. This paper describes the flight test experiments and learning outcomes of this program.*

Introduction

Since 2001, the School of Engineering and Information Technology (SEIT) at the Australian Defence Force Academy (ADFA) has offered a three year Aviation Degree. Unlike many other aviation degrees, the flying training component of the ADFA degree is not integrated throughout the program but occurs in the final year of the degree. This is for a number of reasons including the fact that the flying training is provided by the RAAF at a location remote from the ADFA campus. Consequently, the first two years of the ADFA degree have a different educational emphasis to most other aviation degree programs and this provides the opportunity to present elements of Flight Test.

This paper will describe the ADFA Flight Test Laboratory and the resources required to support the program. Typical experiments and projects will be outlined and the benefits of exposing future pilots to Flight Test will be discussed.

Overview of the Flight Test Program Resources

Central to the Flight Test program is an instrumented Cessna 182RG light aircraft (Figure 1a). In addition to the standard aircraft instrumentation, this aircraft has been fitted with a variety of special instruments and sensors which are described below. All additional instrumentation installed in the School's aircraft was designed so that it could be fitted with minimal modification to the basic airframe. Furthermore, because it was desired to maintain the aircraft in the 'normal' registration category on the Australian register, it was necessary to obtain air worthiness approval before modifying the aircraft. This was done in consultation with a designated engineer as permitted by Civil Aviation Regulation 35 (CAR35). Proposed modifications and designs were discussed with the CAR 35 engineer before formal submission for assessment and approval. Test flights were permitted under a 'Permit to Fly' issued for the proposed flight by the Civil Aviation Safety Authority (CASA). Once modifications were approved, an 'Engineering Order' was included in the aircraft's flight manual. Instrumentation added to the aircraft includes:

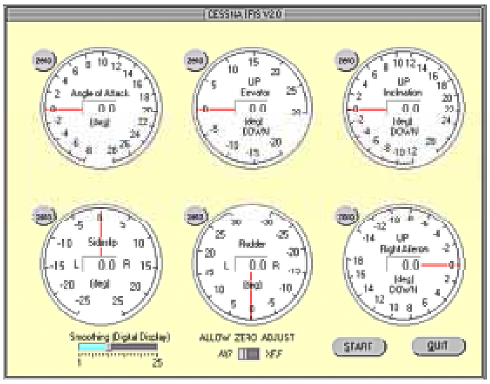
- An air data boom (Figure 1b) providing airspeed, altitude, angle of attack and sideslip (Harrap 2007);
- An inclinometer to measure the inclination of the aircraft's longitudinal axis;
- Elevator, aileron and rudder control surface angular deflection sensors, (Towell, 1999);
- Pitch and roll rate gyros;
- A computer based data acquisition and control system, allowing up to 16 channels of data to be recorded at 100 Hz.
- A wing mounted video camera allowing recording of wool tufts on the wing and fuselage surfaces.
- A pressure belt utilizing low profile mems based pressure sensors. This allows the measurement of wing and tailplane pressure distributions under steady and unsteady conditions, (McCarty and Harrap, 2007).

Figure 1a   Figure 1b

Figure 1a - Cessna 182RG VH-CKA purchased by SEIT in 1998. Figure 1b - The air-data boom mounted on the starboard wing. The boom includes a pitot static system and angle of attack and sideslip vanes.

The aircraft is hangared and the necessary tools and equipment to support the Flight Test program are also stored in this hangar. The aircraft is piloted by two members of staff from the SAME who hold commercial or ATPL licences.

Considerable effort has gone into developing software to support the various Flight Test experiments. Software includes an ‘EFIS’ like display which allows students to manually record data during steady flight manoeuvres (Figure 2a). Flexible data acquisition software allows students to record data during dynamic manoeuvres at recording frequencies of up to 100 Hz per channel (Figure 2b). This computer system has the capability to output signals and data to external displays where required.



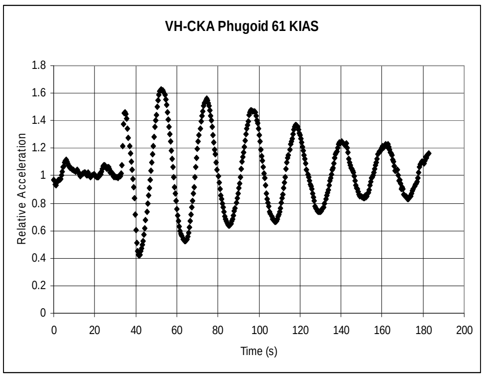


Figure 2a   Figure 2b

Figure 2a - A typical data display using the data acquisition computer. Figure 2b – Longitudinal dynamic stability. Phugoid response following a speed disturbance from trimmed level flight.

Flight Test Experiments and Projects

A variety of Flight tests have been developed since the program commenced in 1994. Currently Aviation students carry out a flight which allows them to investigate aspects of aircraft performance, handling qualities, and stability (static and dynamic) in a 1.2 hour flight. These experiments are flown very efficiently and maximize the students experience and exposure to Flight test. This series of experiments are the result of more than 10 years of development and evolution and rely on the specialised instrumentation fitted to the aircraft described in the previous section.

During the Flight Test experiments, two students are taken up at a time. They work as a team to observe and record data during the flight in a flight-test logbook. After completing the flight, they analyse their data and submit a report in which they are required to demonstrate an understanding of the aircraft's behaviour during each of the tests.

The following experiments are performed during the Test Flight:

- Constant power steady airspeed climbs and descents where the pilot fixes the engine power and then varies the aircraft's rate of descent or climb to alter airspeed. At each airspeed, students record angle of attack, inclination and elevator deflection. This provides sufficient data to predict the aircraft's drag polar (Figure 3a) and longitudinal static stability (Figure 3b). This experiment is repeated in the cruise and landing approach configurations so students can compare the effects of wing flaps and undercarriage extension on the aircraft's cruise performance (drag polar) and stability. (The gradient of the curves in Figure 3b is a measure of static stability.) Through these experiments, students also learn to correct airspeeds for pressure disturbances caused by the aircraft (position error), instrument errors and the effects of changes in air density with altitude.

- Lateral and directional static stability in cruise and approach configurations. In these tests, the aircraft is flown in a series of steady sideslip angles. Students record the corresponding aileron and rudder deflections required to hold the aircraft in each sideslip angle (beta). This data allows students to assess the lateral and directional static stabilities. Students are asked to explain the reasons for any differences in the measured static stabilities in the cruise and approach configurations.

- Longitudinal handling qualities – the effect of thrust, flap and undercarriage extension. During these experiments, the students observe the behaviour of the aircraft with the pilot 'out of the loop'. In other words, the pilot trims the aircraft for steady level flight, changes one of the three parameters and then allows the aircraft to respond without further control input.

- Demonstration of longitudinal and lateral/directional dynamic modes – phugoid, Dutch roll, spiral modes.

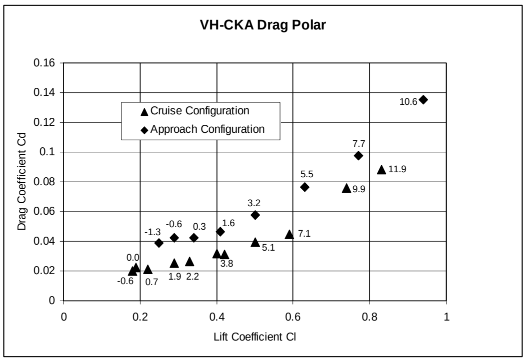


Figure 3a

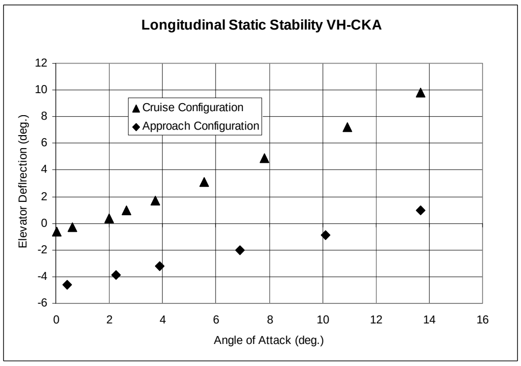


Figure 3b

Figure 3a. Drag polar for Cessna 182RG VH-CKA in the cruise and approach configurations. Figure 3b. Longitudinal static stability. Angle of attack v's elevator deflection for the cruise and approach configurations.

An important feature of the flight tests performed is that they are all low ‘g’ manoeuvres. This is to avoid discomfort and motion sickness and not compromise the student’s ability to observe and record information.

The reader may note that turn performance tests are not included in this list. It was found this testing often led to motion sickness problems as students tried to observe and record turn rates, bank angles and ‘g’ loadings during steady turns. For this reason it was discontinued.

In addition to the Test Flight, students have the opportunity to use the aircraft for project work. A number of very interesting questions have been investigated by students. These include:

- A comparison of angle of attack and airspeed based landing approaches, (Kissock, 2009). In this project, students measured angle of attack using the air data boom and displayed this information using a LED display. A series of landing approaches were flown using airspeed and then angle of attack as the primary reference. The approaches were evaluated from recordings of descent profile, elevator input workload and pilot response. This work led to the design and flight testing of a simple flight director which displayed pitch commands to the pilot based on a reference (target) angle of attack.

- Tailplane airflow during approach and landing (Scott, 2008). This project investigated the changes in airflow direction upstream of the tailplane during landing. This was achieved by placing an array of wool tufts on the side of the fuselage upstream of the tailplane (Figure 4a). A wing mounted video camera was used to record the movement of the tufts. Using the video recordings, the student was able to qualitatively assess the changing flow patterns during landing as the aircraft’s angle of attack was progressively increased and the aircraft became influenced by ground effect. The impetus for this project was the observed propensity of the aircraft to ‘balloon’ during landing flare under certain circumstances.

- Real time measurement of excess power using random climbs and descents (Taylor, 2000).

- Measurement of unsteady wing pressure distributions (McCarty 2008). This investigation used a pressure belt to compute lift coefficients (Cl v’s angle of attack) during rapid pitch manoeuvres. These lift curves were found to be significantly different to those measured during steady flight (Figure 4b).

- Design and calibration of sensors (Towell,1999 and Pakai, 2000).

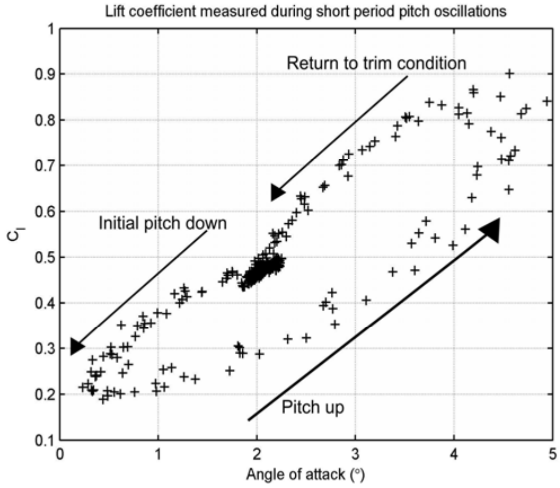


Figure 4a. **Figure 4b**

Figure 4a. Tufts indicating airflow approaching tailplane on a landing approach. Figure 4b. Lift coefficient Cl v's angle of attack during pitch response to an elevator doublet (McCarty 2008).

Learning Outcomes

It is the authors' observation that flying training typically never allows students to observe the natural (uncontrolled) behaviour of an aircraft. Longitudinal, lateral and directional dynamic modes do not feature in typical flying training syllabi. To their detriment, many pilots have never seen demonstrations of Phugoid, Dutch Roll and Spiral modes - yet these are the very behaviours that the are controlling when they learn to fly an aircraft.

The flight tests described in this paper represent a unique opportunity for most of the students undertaking the program. These students are unlikely to participate in flight test activities during their flying careers. One of the key benefits of the flight test program is that it allows the students to study the behaviour of the aircraft with the pilot *out of the loop*. This in turn allows them to better understand their role as pilots.

Student reaction to the ADFA Flight Test program has been very positive and they value the opportunity to apply classroom theory in practice. Comments such as '*a lot of theory came into place*' and '*I especially found the phugoid oscillation experience interesting as I was not sure of the phugoid concept before the lab so I certainly learnt something'* are particularly satisfying and consistent with the contention that 'one or two key experiments' can be instrumental in understanding (Magin, 2000).

Conclusion

The SEIT flight test program is now in its seventeenth year of operation. The resources required and experimental flight tests have been described. Student response to the program has led to the conclusion that flight test successfully links classroom material to the outside world. The airborne laboratory program requires staff who are able to pilot aircraft *and* have a knowledge of flight mechanics. For this reason, laboratories like this are not common even though they provide valuable learning experiences. One of the most important learning outcomes of the program for future pilots is engendering an understanding of an aircraft's underlying dynamic behaviour – and their role in controlling that behaviour.

Although the Flight Test program described in this paper relies on the special instrumentation fitted to SEIT's aircraft, it is possible to perform many instructive flight tests using the standard instrumentation fitted to most light aircraft. The authors would be very happy to assist organisations considering adding elements of Flight Test to their Aviation Programs.

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GRIFFITH UNIVERSITY AEROSPACE SAFETY CENTRE

Timothy J Mavin

Indentifying Minimum Standards of Non -Technical Skills in Airline Pilots Undergoing Command Promotion.

Traditionally, assessment relied heavily on the technical knowledge and manipulative skills of individual pilots. Modern airlines now further expand these measures to include Crew Resource Management (CRM) skills. The recent introduction of 'non-technical skills' has aided in making these CRM skills more explicit. However for grade integrity, a thorough understanding is required of how the categories within non-technical skills are related. This presentation reports on research that has reviewed the interrelationship of technical and non-technical skills of pilots undergoing initial command training.

Educational and professional institutions measure individual performance in varying ways. When high levels of complexity within given vocations are present, assessments become difficult where there is a need to apply scores to a particular performance (Shay, 2004). These difficulties can create variations within the assessment process and lead to reduced levels of grade integrity. Recently Sadler (2009) outlined that for grade integrity to be maintained during assessment, three important factors must be adhered to. Firstly, evidence being gathered must be of a valid nature. Secondly, assessment tasks should be rigorous enough in depth and breadth so that resilient judgments can be made. Thirdly, final grade coding is based on sound theoretical understandings, enabling final performance to be accurately reflected in the grade achieved. Criterion based assessment methods have been developed to make performance expectations more transparent. The use of various coding formats, in the appearance of word and sentences describing a particular performance is one example of criterion measures. Developing these criteria is difficult when tacit knowledge is imbedded in practice. Though difficult, it has been argued that complex understandings of work functions can be teased out in explicit terms by assessors developing a rationale behind their qualitative measures (Sadler, 2005).

The flight deck of a commercial aircraft is representative of a complex working environment. Traditionally assessment relied heavily on the technical knowledge and manipulative skills of individual pilots. This legacy is still seen within the current regulatory frame work of assessment guidelines. However, research into aviation incidents and accidents over the last thirty years shows technical skills fair much better than less tangible skills of situational awareness, management and communication (Helmriech, Merritt, & Wilhelm, 1999). These skills came under the banner of Crew Resource Management (CRM) and are now an imbedded and an integral component of all airline initial and recurrent training programs. Research in aviation and other high risk professions further expanded the area of CRM with what is now called Non-Technical Skills (NTS). NTS were broken into two key areas; social and cognitive skills. With each being further split into two sub-categories. Social skills included 'team skills' and 'management/leadership', while cognitive being divided into sub-categories of 'situational awareness' and 'decision making'. Criterion based measures were developed with specific 'word descriptors' for each sub-category to aid in making implicit skills more explicit. They assist check captain's standardising assessments in describing the performance of an individual or crew (Flin & Martin, 2001). However, the current descriptors define good and poor practice. They do not define the complex relationship between each category or the inherent difficulties of finalising a grade for overall performance. As outlined, for grade integrity, final grades must be based on sound theoretical understanding.

This presentation describes recent research that has explored understanding of the minimum standards of NTS required of an airline captain. The research was based on a phenomenological research approach based on interviews focusing on pilots undergoing promotion to airline captain. The scope of the research involved interviews with airline check captains with a mean experience in the role of “Check Pilot” of 28 years. The findings showed not all NTS areas are considered equal. It was established that NTS, such as management, cooperation and communication though important, were not the main focus during marginal assessments. However, situational awareness and decisions considerate of risk were found to be mandatory requirements. In addition, pilot’s exhibiting lost situational awareness at any point during the assessment was unlikely to pass. The findings attempt to clarify the relationships and importance of the different non-technical skills categories.

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New technologies for the student pilot

by
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Introduction

Today's airline pilot works on a cockpit that has been designed for maximum safety and efficiency. Pilots' own airmanship and experience play an important role in this cockpit but so do the numerous devices that provide information to the pilot and help control the aircraft. Student pilots, on the other hand, learn in a cockpit that prepares them to fly in the way airline pilots used to fly decades past or in a way relevant only for single pilot operations in small aircraft. Nowadays, however, students may be closing the gap between a hard cockpit and a glass one by bringing devices that add a bit of information and/or controllability to their flying. They know that there are devices that can be used in the cockpit and are affordable to them, especially if they are integrated into mobile telephony. This research, thus, explores the information needs of today's student pilots, and describe which technologies the student would purchase if they could in order to support those needs better.

Methods

This research is an exploratory study regarding flight management informational needs of student pilots in the role of single-pilot operators. The features provided by three different GPS-based technologies have been used to assess these pilots' needs in regards to information in the cockpit. These technologies were a mobile phone with integrated GPS for post-flight analysis, a real-time fleet tracking technology, and a flight management system program for Microsoft Windows-capable devices (including mobile phones).

A convenient sample of seventeen student pilots that had passed their ATP examinations and had experience with navigation flying was selected for this study.

The different informational features of each technology were presented to the participants. The combined list of features amounted to 28 variables. Participants were asked, firstly, to select those features they would like to have at their disposal while flying, and secondly, to assess the relative importance of the selected features in a five-anchor Likert scale. As a third measurement, they were also asked to decide which technology they would purchase if there was no impediment for them to do so.

Results

Results show that these pilots valued highly the following features: onboard display of navigation charts during flight; airspace awareness functions during flight; low running costs; post-flight display of flown track on navigation charts; pre-flight route planning (including weather, etc); TCAS functionality; and portability. Among available technologies in the market, 53% of the sample would purchase one that provides an integrated flight management system. Furthermore, none of the participants opted for a remote tracking system.

Conclusions

Aviation training is rather conservative. Student pilots are trained in a flight environment that was appropriate decades ago and, thus, do not benefit of technological advances available nowadays in the market. In so doing, efficiency and safety may be being compromised. Students would like to have, for example, electronic information for navigation charts, airspace awareness, route planning and traffic collision, all of which manage safety and efficiency better than paper-based material. Incidentally, it is also what they would have if they flew for an airline.

The further development of the Bachelor of Technology in Aviation degree program at the Australian Defence Force Academy

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Abstract

The Bachelor of Technology (Aviation) degree program at the Australian Defence Force Academy commenced in 2001. The degree met a requirement of the Australian Defence Force whereby pilot candidates completed two years of academic studies before commencing flying training. This paper describes the evolution of this degree program from a two-year academic program with a strong engineering focus to a three-year academic program with a added focus on the behavioural sciences – especially as applied to the discipline of aviation.

Introduction

The University College at the Australian Defence Force Academy (ADFA) is a College of the University of New South Wales (UNSW) and has provided undergraduate and postgraduate degree programs for the Australian Defence Force (ADF) since ADFA's commencement in 1986. Normally, those ADFA students who have been selected to be pilots complete a three-year academic program before commencing any flying training. In November 1998, the Air Force Commander of Training communicated a Statement of Requirement for a Bachelor of Technology in Aviation Degree Program (B'Tech Av) to the University College. Enrolments to the degree were to be restricted to prospective pilots and called for two years of study at ADFA followed by a twelve month flying training program provided by the ADF and BAE Systems Australia. One of the major benefits of the proposed degree program was that it allowed students to begin their flying training one year earlier than their ADFA peers. This was important to the ADF as there was anecdotal evidence that younger students had better success at pilot training (Given 2002).

The Statement of Requirement set in train a cooperative development program between the UNSW and the ADF that culminated in the ADFA Bachelor of Technology (Aviation) degree program delivered by the School of Aerospace, Civil and Mechanical Engineering (SACME). The first ten students enrolled in this new program in 2001 and the degree program received full accreditation from Engineers Australia - the national peak body for all engineering disciplines - in 2006.

This paper will discuss the development and evolution of the Bachelor of Technology (Aviation) degree program through a process of consultation and review with the ADF. By presenting a convincing case regarding educational outcomes and responding to a perceived need within the ADF, the degree program is currently being transformed from an engineering degree with a large aviation safety component to an aviation degree with a focus on aviation psychology as well as human factors in aviation.

As well as providing a potted history of this process, this paper will provide the rationale behind the promotion of behavioural science and aviation psychology as well as human factors in an aviation degree.

Program Development

Central to the initial statement of requirement for the Bachelor of Technology (Aviation) program was that flying training provided by the ADF would be part of the three-year degree program. This may not seem to be an unusual requirement as, at the time, numerous Australian university aviation programs integrated flying training with academic studies. However, what set the proposed ADFA program apart was that the first two years of the degree would be provided by the UNSW at ADFA and the third year would be flying training to air force 'wings' standard provided by the ADF. For this reason, it was necessary to develop a model for this degree that was different from existing Australian university aviation programs.

To address this issue and formulate a model for the new program, a working party was convened. This party included representatives from the Royal Australian Air Force (RAAF) Training Command, the UNSW, ADFA, the three services (Navy, Army and Air Force) and BAE Systems Australia. (BAE Systems Australia provides the ground school component to pilots undergoing basic flying training at Tamworth, NSW.) The work of this party culminated in a formal proposal to the Academic Board of the UNSW and then a contract between Defence and the UNSW (Harrap, Burdekin & Lewis 2007).

The proposal, accepted by both the UNSW and the ADF, was that the emphasis of the ADFA component of the program would be aviation safety through an understanding of the aviation system as a whole – both from a technical and organisational point of view. Safety was agreed to be a primary consideration for ADF pilots and this emphasis was seen to complement the flying training undertaken later in the degree program (Harrap et al 2007).

Having decided on the basic structure of the degree, the next step was to develop an appropriate curriculum and recruit staff specifically to develop and present coursework in aviation safety. In addition to aviation safety, new courses were also developed in aviation systems, aerodynamics, meteorology, flight mechanics and aviation resource management. A number of external bodies and individuals were consulted to refine and guide the development of the program. These organisations included the ADF Directorate of Flying Safety (now Directorate of Defence Aviation and Air Force Safety (DDAAFS), The Australian Transport Safety Bureau (ATSB), ADF Basic Flying Training School (BFTS) at Tamworth and the RAAF No 2 Flying Training School (2FTS) at Pearce.

The major academic challenge in designing the Bachelor of Technology (Aviation) program was posed by the fact that the military flying training and associated ground school did not begin until the third year of the degree program. It was necessary to design the first two years of the program in a way that complemented the flying training. Because the program was to be provided by an engineering school, it was decided that the program would blend coursework in aviation and engineering basic sciences. The first year of the proposed program would share many courses with the SACME's Aeronautical Engineering program. This provided the economy of scale and administration that has become the norm at most contemporary educational institutions (Toohey, 1999).

Since the inception of the Bachelor of Technology (Aviation) program to the present day, the number of SACME academics who have expertise in aviation human factors and aviation safety management systems has grown from one to three. In 2001, there was only one such qualified person at SACME. Another member of staff was a practicing commercial pilot and, as well as co-ordinating the Bachelor of Technology (Aviation) program, this person piloted the school's especially instrumented aircraft conducting aeronautical engineering flight laboratories (Harrap, 2007).

A second "aviation psychologist" joined the aviation team in 2002. Whilst this person brought with him experience as a pilot and crew resource management facilitator for a major Australian airline, he was mainly deployed teaching the aeronautical engineers and candidate pilots engineering-type courses as well as sharing the workload involved in flying the aeronautical engineering flight laboratories.

The Bachelor of Technology (Aviation) program has been reviewed by a number of organisations. Indeed, the ADF commissioned their own review of the degree just one year after its launch (Given, 2002) and a second follow-up review the next year (Given 2003). The results of these reviews were favourable and both recommended that the degree should continue. The fact that the Bachelor of Technology (Aviation) degree was granted full accreditation from Engineers Australia in 2006 reflects the strong engineering focus of the program.

Aviation Studio

Notwithstanding the strong engineering focus of the program or perhaps because of it, the academic staff worked to develop greater emphasis on aviation human factors and aviation safety management. For instance, an Aviation Studio was built and developed. The word 'studio' is used in here to describe 'a general approach to interaction with students, that is instructor facilitated, student centred and very hands on' (Little and Cardenas, 2001). The purpose of the Aviation Safety Studio is to expose students to the many facets of Aviation Safety through studies of aviation scenarios that can include aircraft accidents or incidents in an innovative, enjoyable and educational environment.

In figure 1 it can be seen that the aviation studio includes a flight control console, (two-place seating), equipped with dual control yokes; two USB, add-on, side-stick controllers; four interchangeable throttle quadrant configurations and two sets of rudder pedals. Microsoft flight simulator runs on a computer that projects a 150° image on three screens. As the pilot / operator sits at the console, behind him or her are 24 seats arranged on three tiers. Effectively, this results in one or two crew being able to 'fly' the entire room of 24 spectators in an aeroplane that can be, for instance, a B747; A320; Beechcraft Baron; Cessna 150 or an F18 Hornet. A work station with a linked computer and screen allows an experimenter or investigator to control and record the flight including flight and controller parameters. Recent additions to the studio include a cap-mounted head tracker. This will allow the experimenter to see and record “where the pilot is looking”.

Figure 1: The Aviation Studio showing a single pilot at the control console.

Another example of the promotion of aviation human factors; aviation safety management and aviation psychology was the development of an aviation-related problem-based learning (PBL) research project which students complete immediately prior to their departure from the Academy for flying training. The PBL research project is structured to encourage students to adopt a deep approach to learning through problem solving and independent study – the benefits of which have been discussed by Biggs (1999) and Lewis (2008). Reflecting the hitherto strong engineering focus of the Bachelor of Technology (Aviation) degree, some of the projects have had a strong aeronautical engineering focus. For instance, one such project investigated landing approach techniques where the student used the school’s airborne laboratory to analyse and compare landing approaches flown with reference to airspeed and angle of attack (Welsh, 2005). Another project involved a student characterising the turbulence generated by a prominent hangar close to the landing threshold at Canberra Airport (Nelson, 2004).

More recently, many students have sought supervision by the aviation psychologists in SACME for more human factor-related experimental paradigms and projects. For instance, a recent study into the effectiveness of airport movement area guidance signs took the perspective of a pilot taxying an aircraft and considered the numerous cognitive skills required of pilots and the possible effects of external factors on those skills (Barclay and Lewis, 2008).

The aviation project was originally scheduled to be conducted during pilot training at Tamworth. A large portion of the content of the standard BAE Systems Australia ground school, conducted at Tamworth, is covered during introductory courses at UNSW@ADFA. In the planning of the original degree program, provision was to be made for the aviation project to be conducted in the resultant ‘gaps’ in the Tamworth ground school. Shortly after the implementation of the first aviation degree program, this provision was refused by the Officer Commanding BFTS. All BFTS pilot candidates had to do the entire BAE Systems Australia ground school. Also, at Tamworth, students would have had limited access to the aviation studio; library and workshop facilities as well as some supervisory staff. As a compromise, the bulk of the project was conducted during a summer school. This summer school was sandwiched between the end of the academic year and commencement of flying training at BFTS Tamworth. Ultimately, this arrangement has proved unsatisfactory mainly because holding courses during non-session (term or semester) time can mean that University staff are not available to be supervisors of the student projects. This unavailability may be due to research activities; attendance at conferences; recreation leave etc.

In early 2007 a remedial proposal was tabled to another advisory committee. This committee also included senior officers of the ADF. The proposal sought to revise and expand the academic program to two and a half years with a pass at the Basic Flying Training School completing the requirements for the granting of a Bachelor of Technology (Aviation) degree. One ADF representative on the advisory committee was the Officer Commanding the RAAF Training Wing – Group Captain Sawade. Group Captain Sawade not only recommended the proposed changes be adopted but also suggested that the degree programme be made available to additional aviation-related ADF job categories. These aviation-related job categories include Air Traffic Controllers and Air Operations Officers. Group Captain (now) Air Commodore Sawade also expressed the notion that a Bachelor of Technology (Aviation) Degree Program for Air traffic Controllers and Air Combat Officers would give a “career path” and better ADF career management to these flying operations categories.

The recruitment of an additional pilot and psychology qualified academic in late 2007 allowed the Bachelor of Technology (Aviation) degree program to expand to two and a half years of academic studies. These studies were to be followed by nine months or so of basic flying training.

While these changes to the academic program were ratified by the Academic Board of the University of New South Wales and included in the 2008 University College handbook, they were not accepted by the ADF. However, due to delays in the ADF flying training ‘pipeline’ the aviation project was undertaken by the third-year Bachelor of Technology (Aviation) students in the first academic session of 2009.

The Three-year Bachelor of Technology (Aviation) Degree Program.

Surprisingly, in early 2009, the senior officers in charge of the military side of the UNSW@ADFA campus, requested from the University, a three-year Bachelor of Technology (Aviation) degree program. The stated purpose of this proposed change was to ameliorate the scheduling problems when a three-year military training program [AMET] is condensed into a two-year timeframe. It has been suggested by our military colleagues that such a condensed program is not achieving all the Officer Quality Attributes of an UNSW@ADFA graduate.

The three-year Bachelor of Technology (Aviation) degree program will provide students with an academic degree program to be completed within a three-year time frame at the Academy. It will also provide students with a Bachelor of Technology (Aviation) degree that is not contingent on attaining a pass at Flying Training. The University of NSW will be able to provide better time management for the duration of the degree so that students will receive the required supervision and tutelage of academic staff. The three-year Bachelor of Technology (Aviation) degree program will eliminate the problems associated with the ADF flying training pipeline where students are spending in excess of four and a half years as Officer Cadets.

To achieve the economy of scale and administration that has become the norm at most contemporary educational institutions (Toohey, 1999), the Bachelor of Technology (Aviation) and the Bachelor of Technology (Aeronautical Engineering) will run in parallel as much as is possible and have a common academic first-year. Toward the conclusion of their first year the students elect to join an engineering stream - The Bachelor of Technology (Aeronautical engineering) or a human factors / behavioural science stream - The Bachelor of Technology (Aviation)

Advantages of the Three-year Bachelor of Technology (Aviation) Degree Program

The three-year Bachelor of Technology (Aviation) degree program will provide enhanced educational outcomes and graduate attributes as the degree program evolves from an engineering programme with safety management systems courses to an aviation degree with a focus on behavioural and cognitive science courses. By running two degree programs in parallel for the first year there will be a more efficient use of University and Defence staff and facilities to achieve these enhanced educational outcomes.

If the Bachelor of Technology (Aviation) degree program is made available to Air traffic Controllers and Air Combat Officers there is the possibility of greater recruiting success and potential for more students and officer cadets at the Academy.

The three-year Bachelor of Technology (Aviation) degree program will offer an element of choice to students in their second and third years. Such choice will satisfy student learning objectives, talents and predilections. Also, it is anticipated that there will be better student motivation – students graduate with their cohorts from other degree programs [not the present ‘provisional’ graduation at the end of second-year].

By maintaining an engineering focus with a common first year with the engineers it is anticipated that the Bachelor of Technology (Aviation) degree program will continue to be accredited by Engineers Australia.

Conclusion

On the 18th June 2009 the Undergraduate Education Committee of UNSW@ADFA accepted the three-year Bachelor of Technology (Aviation) degree program. Whether the three-year program eventually receives the imprimatur of the higher echelons of the ADF remains to be seen.

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AVIATION SAFETY

Memes in Aviation

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Abstract

After nearly two decades of attempting to understand accident causation by looking for latent errors and systems failures there is now a questioning of how this approach can explain accidents that seem to arise from people acting in a manner that is seen to be part of normal operations. A new look at influences acting upon pilots and operational crew may enhance our understanding of aviation accident causation and safety. The following discusses memes – units of social information that are replicated and transmitted through a population – and how understanding the viral actions of memes may help explain the development of crew behaviours that are counter to safe practices. Examples from within aviation are provided to illustrate both the positive and negative outcomes the transmission of memes can have.

Causes of Accidents

Attributing reasons for accident causation has through the history of aviation seen movements from mechanical reasons to pilot error to systemic reasons. Mechanical error was an obvious cause of accidents in the early days of flight where the early aircraft were fragile and under powered.

As the mechanical reliability of the aircraft improved the causes of accidents and incidents in were attributed to the individual operator, (Paries and Amalberti, 2000). The cause of the accident is seen to be pre-dominantly arising from the actions of the human participants.

From the beginning of the 1980's there was a further change to understanding accident causation. Paries and Amalberti, (2000) describe this change as one where poor resource management including poor team work by crews were seen to be the reasons for the accidents and incidents. The causes of accidents and incidents arose from within the organisation and the culture of the organisation. The best known model describing this cause of accident is Reason's (1990) latent and active errors. Helmreich (1992) described the Dryden accident as a "system failure" (p. 2).

Examination into systemic error developed momentum through the 1990's with national regulatory bodies as well as international organisations accepting the need for examination of organisations and their systems to be examined when looking at causes of accidents.

For Shorrock, Young and Faulkner, (2005) there is now a need to re-examine the role of active errors in accident causation to counteract the overemphasis on latent errors. There is a need to understand the influences and factors that may lead the sharp-end operators to choose a path of action that is different to the organisation's standard practices. Have the sharp-end operators been deeply influenced, as Pech and Slade, (2004) suggest, by "a hidden and complex phenomenon" (p. 452) leading to behaviours and practices not necessarily acceptable to management in the pursuit of organisational goals? These behaviours and practices arise from units of social and behavioural information that are labelled memes.

Understanding Memes

The meme is seen to be a replicator of an idea or behaviour which jumps from brain to brain in a non-genetic manner, (Blackmore, 1999).

It is generally agreed that the concept of memes originated with Dawkins in 1976 in his book the *Selfish Gene*. He looked to explain the development of social culture and transmission of ideas and thoughts by likening this transmission to genes and the transmission of biological information leading to biological evolution. As genes move from person to person within a population so too do units of social culture. The word *meme* was chosen by Dawkins as it had a Greek root *mimeme* meaning likeness and also *meme* rhymed with the word gene.

Memes share the same characteristics of genes, including their ability to spread easily and quickly through a population, their ability to survive over time, as well as their copying fidelity – how faithfully the meme is transmitted without change.

The idea of cultural replicator and transmission was understood prior to Dawkins' use of the term "*memes"*. McGrath (2005) notes the use of the term "culturgen" within North American socio-biology prior to Dawkins' *meme*. McGrath (2005) ascribes the success of Dawkins' use of the term meme to the neat and memorable terminology and the wider audience afforded to Dawkins' writings.

The spread of memes is indiscriminate and their effect could be positive, harmful or neutral. Dennett (1990) saw memes replicating themselves whether they were for the good or otherwise of the host population. Memes merely replicated. Being good at replicating does not necessarily mean a meme has a positive contribution to make. Some memes are identified by Dennett (1990) as being positive, some are more troublesome and yet some memes that are nasty flourish and replicate despite their destructiveness – an example being anti-Semitism. These later memes are labelled toxic memes.

Dennett (1990) also noted that the meme needed a meme-vehicle. The meme is invisible and the meme-vehicle is physical. The methods for passing on or transmission of memes can include language or reading or instruction Dennett contends that at some stage in the life of a meme - which spreads extremely quickly around the world – it must reside in a human mind which he calls a "meme-nest".

We can thus use Pech's (2003) definition of a meme as:

> "units of information, ideas or mental representations, culturally transmitted instructions and the key element appears to be that these ideas or units of information are contagious, self-replicating and they are imitators (p. 173)."

The concept of memes has developed outside of aviation and has been applied to different academic and non-academic disciplines. Within aviation there is evidence of transmission of memes and the development of memeplexs that are both beneficial and toxic.

Memetic Consequences

This transference of units of information and ideas - memes - can be used as a means of maintaining the expected practices and attitudes of the organisational members. Memes can also have a place in understanding the changing execution of tasks. As Dekker (2005) asserts, the greatest threat to safety in a sociotechnical system is the "drift into failure" (p.18). This drift is where the practices of the workers slowly move away from the promulgated procedures.

Memes lead this drift away from expected organisational practices and become the normal practice. An accident may occur when normal crews are acting in a normal

manner inside a normal company, (Dekker, 2005). Researchers into the mid-air collision over the Amazon jungle note the pilots of the Embraer Legacy business jet accepted without challenge an airways clearance that was different to their flight plan, (de Carvalho, Gomes, Huber and Vidal, 2009). It was normal practice to receive clearances different to those planned for. The pilots were familiar with changes to planned flight routings and with authorisations that were different to those originally planned for.
The transmission of memes can not only influence individual practice but leads to evolution in the operating culture. Properly controlled this can be a positive influence and continue to align the operating practices with the goals of the organisation, (Pech and Slade, 2004). Some memes are however toxic, with a message that runs counter to the organisational goals and leads to undesired outcomes. A toxic meme, is defined by Pech and Slade (2004) as "a meme that is an expression of an undesirable attitude", (p. 455).

Memetic Examples in Aviation (I): Transmission of Memes Between Pilots

As memes are defined as the passing on of ideas or behaviours (Blackmore, 1999, Pech, 2003) it is easy to see memetic influences within aviation. The replication and transmission of ideas and thoughts can be vertical as in the case of flight instruction and also horizontally across different groups of pilots.
The horizontal transmission of memes is best evidenced in the remembering of past occurrences. The importance of prior experiences recalled by the pilot facing a Critical Flight Experience cannot be understated. The vast majority of pilots (89.3%) surveyed in a study of examining recall of previous incidents found the previous case to be "moderately or very useful" and 84% of the pilots believed the previous case "to have been a key factor in the decision they took at the time" (O'Hare & Wiggins, 2004, p. 281)
The ideas and behaviours – the memes – arising from past experiences influence the decisions made by pilots. The transmission of the memes can occur through formalised means such as training and standardised procedures, and officially published material or through non-formal methods. Direct evidence of the beneficial effects of memetic transfer of ideas and behaviours is seen in two incidents where loss of life was averted.
The first instance was the case of the A300 freighter which was hit by a surface-to-air missile when climbing out of Baghdad. This caused the aircraft to lose all hydraulics and thus the pilots no longer had primary flight controls. Using asymmetric power the pilots gained a degree of control. As they returned to Baghdad for landing they remembered the efforts of the crew in the United Airlines DC 10 who landed at Sioux City, (Learmount, 2004). The United pilots had also lost primary flight controls after their number two engine disintegrated and fragments from the engine severed hydraulic lines. The memes generated by the experiences of the Sioux City pilots; their actions in controlling the aircraft and excellent crew work were transmitted to and replicated by the Baghdad pilots who landed safely and were able to evacuate the aircraft without loss of life.
In the second example pilots of a Scandinavian airliner suffered a double engine failure during take-off from Arlanda airport, Stockholm, after clear ice still on the aircraft broke away and was ingested by the engines. After experiencing compressor stalls and surging both engines failed. The pilots guided the aircraft to the ground where the aircraft hit a tree on the roll-out and broke into three pieces. Despite the off-aerodrome landing and the subsequent break-up all persons on board the aircraft survived. Being faced with a situation that was unique for these pilots they remembered the Kegworth accident(where

the pilots shut down the operational engine) “and did their very best to avoid making the same mistakes as the pilots in that accident”, (Martensson, 1995, p. 315).
At both Baghdad and Gottrora the transmission of memes helped pilots reach a safe outcome despite testing conditions.

Memetic Examples in Aviation (II): Transmission of Memes Between Passengers
The communication of the pre-flight safety briefing made by the cabin crew to passengers prior to each flight has been affected by toxic memetic influences. Parker (2006) found that passengers generally did not pay a great deal of attention to the briefings despite most passengers believing that cabin safety was important - over 70% of respondents described the safety information contained in the safety briefing as being either very helpful or extremely helpful. However Parker (2006) also noted the existence of memes which transmitted the idea between passengers – especially frequent flying passengers – that paying attention to the safety briefing was a socially unacceptable practice. This meme was reinforced by passengers observing the non-attentiveness of other passengers. The frequent flyer passengers saw those passengers who did pay attention to the safety briefing as being from the margins of the flying public such as elderly, infirm or foreign –population groups the frequent flyers did not believe they belonged to - thus further reinforcing the meme that it was not necessary to pay attention to the safety briefing.
It is not be surprising that this meme of ignoring safety messages is strongly felt within aviation as the meme has antecedents in maritime passenger transport. In May 1915 the German U-Boat 20 torpedoed the passenger ship Lusitania off the south coast of Ireland leading to nearly 1200 people being killed. Prior to the Lusitania departing New York the German Embassy had published in the local media a warning to passengers that a state of war existed between Germany and Great Britain and ships flying the flag of Great Britain or her allies (as the Lusitania was) would be open to destruction. The warning concluded with a caution that passengers travelled at their own risk (Preston, 2002). Onboard the Lusitania lessons from the sinking of the Titanic had been learnt, so it carried a far larger number of life preservers than there were passengers. Life boat capabilities were also greater than the number of passengers that could be carried. Notices on how to wear the life preservers were posted on the walls of passenger cabins and other prominent positions around the ship, (Preston, 2002).
Despite the warning from the German embassy, and in spite of the prominent and many displays of instructions regarding how to correctly wear the life preservers, when the Lusitania began to sink many people did not know what to do with the preservers or how to correctly wear them. Some passengers managed to place their preservers on themselves wrong way up thus when they entered the water the preserver actually forced the passenger under the water and drowning the passenger. These bodies floated feet up. Other passengers managed to place the preservers on themselves back to front so the preserver continually forced the passenger’s head under the water, (Preston, 2002).
The lack of understanding of how to correctly use the life preservers occurred because the passengers did not pay attention to signage with instructions on their usage. As one surviving passenger stated afterwards: “although instructions on how to put on lifebelts were in a conspicuous place he paid no attention to them” (Preston, 2002, p. 463). This is despite the clear warning that had been made to the passengers prior to the departure of

the ship. The meme of passengers not wanting to be disturbed with safety procedures is one of longevity and able to be passed through different forms of passenger transport.

Memetic Examples in Aviation (III): Cabin Crew and Flight Crew; Toxic Memes
As well as explaining how ideas are spread through a population such as pilots and passengers, memetic theory may help explain how ideas with little advantage or benefit to safe operations can stubbornly continue to replicate themselves and be transmitted through the population. These ideas build a culture from which arise behaviours that are not beneficial to the organisation. These memes are toxic to safe operations.

A glaring example of toxic memes within aviation is the divide between pilots and cabin crew. Cabin crew feel they cannot talk to the pilots about safety and other operational issues, (Murphy, 2001). This was brought to light in the aftermath of the Dryden accident. One cabin crew member who survived the Dryden accident said to the ensuing Royal Commission of Inquiry that there were two crews at work, the crew at the front and the crew at the back and there was little communication between the two crews, (Moshansky, 1992).

Although the cabin crew on the accident flight at Dryden had information vital for the safety for the flight they did not communicate with the pilots because of the communication divide. That the two groups of crew should not communicate with each other was conventional practice for the time. Maurino, Reason, Johnston, & Lee, (1998) outline the then current thinking as being:

> "An industry culture which did not (and to a large extent does not) encourage cabin crew to discuss operational matters with flight crew." (p. 71)

This meme is further illustrated by Chute and Wiener (1996) who identified one incident where a fire had started in the cargo hold of the aircraft due to faulty packaging around dangerous goods. Although there was smoke in the cabin and the floor of the cabin had become so soft that passengers had been re-seated, the pilots refused to take seriously the communications from the cabin of any imminent danger. Within this industry culture the meme of non-communication was replicated and passed between members of cabin crew. The meme had spread wide and far.

This meme was also active during the Kegworth accident. The cabin crew and passengers realised the pilots had shut down the incorrect engine but did not inform the pilots. The meme of non-communication was very strong and the official report identifies that if communication had been made between the cabin and the pilots the accident may have been averted, (AAIB, 1990).

The strength of this toxic meme was such that at the time of the accident there was no requirement for training in communications between the cabin crew and the flight crew, (AAIB, 1990). This allowed the toxicity of the meme to continue to flourish and influence cabin crew and pilot behaviour.

The longevity and stubbornness of this meme is illustrated by an incident in Western Australia when in 1996 a Dash 8 aircraft on descent to Broome struck a wedge-tailed eagle. The resulting damage led the pilots to shut-down the number one (left) engine. As the pilots lowered the undercarriage for landing a warning light illuminated indicating that the undercarriage was in an unsafe position despite being extended. After holding to the north-west of the aerodrome to try and solve the undercarriage problem the crew returned the aircraft to the aerodrome and landed, running off the runway in the latter part of the landing roll, (BASI, 1996). The flight crew of two pilots while being busy handling a demanding situation, told the one cabin crew member that her assistance was not required. The result was that the cabin crew member did not prepare the passengers for a non-normal landing, (BASI, 1996).

The resident meme of pilots not talking to cabin crew was stronger than a newer meme that had been introduced to the pilots through a training course. The pilots had been involved in a CRM training course eight months prior to the incident. The training course had involved cabin crew. Despite training in CRM issues with cabin crew the pilots did not utilise the resource available to them in the form of the cabin crew member.

The cabin crew member working in the cabin of the aircraft had not been able to attend a CRM training course due to rostering clashes (and the company policy did not require cabin crew to complete a CRM course) but had watched a video on the Dryden crash which had been produced to "highlight the importance of good communication between cabin and flight crews in maintaining operational safety" (BASI, 1996, p. 7). Despite this – albeit brief – training received by the cabin crew member the strength of the resident meme that cabin crew did not communicate with pilots meant that she did not contribute to the provision of a safe outcome.

Conclusion

After nearly two decades of looking at systemic causes of accidents there is a renewed interest in the role that active errors and the actions of pilots have in accidents and incidents (Shorrock, et al, 2005). It has been argued that the practices of the pilots and crew may have drifted in a slow and unremitting manner away from promulgated practices (Dekker, 2005). When an accident or incident occurs it seems to arise from normal people acting in what may be construed to be a normal manner. It has been argued that an increased understanding of the influencing memetic factors on individual practice and the changes in operating culture will contribute a crucial service to aviation safety.

A large body of research has been developed outside of aviation around the concept of memes, units of social information that are replicated and transferred between members of a population – sometimes in a viral-like manner. Dawkins, the originator of the term memes, has likened the meme concept to biological genes in that they spread information easily and quickly through a population that can lead to shifts in behaviours in a positive or a negative manner.

The concept of mapping 'aviation memes' and the benefits as well as the potential threats they may pose to aviation safety has been presented as a new means of addressing accident and safety concerns. It is argued that early identification of positive memes and encouragement of their transmission through training and changes to standardised procedures can positively impact on aviation safety. The wider transmission of these positive or constructive memes would provide a greater experience depth for all pilots and enhance their decision making. Within the business context Pech and Slade (2004 p 256) have argued "For managers seeking to influence behaviour, meme theory becomes a powerful instrument". Similarly it has been argued that a greater understanding of meme theory will aid decision-making in the aviation industry.

Identification of toxic memes and their negative affect would also be of benefit to aviation safety. These toxic memes can alter attitudes as well as actions. As discussed above the toxic meme may be very strong and the introduction of new memes such as CRM may not be enough to overcome the existing resident meme.

There have to date been few diagnostic tools available to map memes. Pech and Slade (2004) have provided a conceptual model for meme mapping which will provide the starting point for the mapping of memes within the aviation domain, especially for identifying and altering toxic memes.

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Confirmation bias in general aviation lost procedures

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Background

When general aviation pilots become lost whilst flying, their chance of accident or incident is increased (e.g., controlled flight into terrain, forced landing). Although in practice pilots may become lost, in principle they will almost always have some idea (a hypothesis) as to their true location. Hypotheses, however, can be wrong and therefore must be tested by seeking evidence to support them or evidence to falsify them. It is generally accepted the latter strategy is the stronger as evidence can almost always be found to support a hypothesis, but seldom does it provide good evidence as to the validity of the hypothesis. Contrarily, a single piece of disconfirmatory evidence can show a hypothesis is wrong.

Based upon our understanding of a number of earlier incident reports in which pilots were unsure of their true location, we predicted that a 'hypothesis support-seeking strategy' would be used, which could lead to pilots wrongly believing they were no longer lost. We tested this hypothesis in five separate studies, using pilots, cognitive psychology students, and experienced orienteers.

Method

Using three different map-based scenario tasks, participants were asked imagine that they were lost but had a hypothesis about their location. We actually provided their 'location hypothesis' by giving them a map with a circle drawn on it, which we told them was where they probably were located. In fact the hypothesis was wrong, and participants were actually located elsewhere (a place where they could also reasonably be expected to be located).

Participants were instructed to choose one landmark (of three provided) that they believed was most useful in deciding whether they were (or were not) at the hypothesized location. Two of the three landmarks were consistent with the hypothesized location and one was inconsistent. However, all three landmarks were consistent with a second, true location. The 'correct' decision would be to choose the 'inconsistent' (disconfirmatory) landmark.

We conducted 5 studies: i) n = 66 pilot students, ii) n = 36 cognitive psychology students, who had recently received a lecture on confirmation bias; iii) n = 21 experienced orienteers; iv) n = 18 pilot students who had just received a lecture on confirmation bias; and v) n = 46 cognitive psychology students who had recently received a lecture on confirmation bias (29 received an additional explanation of how confirmation bias may lead to false positive support for a hypothesis; 17 did not receive this additional information).

Results

Overall, pilots and cognitive psychology students used a confirmatory approach to reorientation, whilst orienteers used a disconfirmatory approach. The mean number of disconfirmatory choices were: Study 1(Pilot students) .55, $t(66) = -5.40$, $p < .001$ (Note: 1 disconfirmatory choice of 3 would be expected by chance alone, so single-sample t-test was used for each comparison with test value set at 1); Study 2 (Cognitive psychology students).56, $t(35) = -4.78$, $p < .001$; Study 3 (Orienteers) 2.00, $t(21) = 6.48$, $p < .001$. In study 4, pilots students were given a short lecture explaining the shortfalls of using confirmatory evidence to ascertain one's true position when lost; although still favouring confirmatory evidence, performance (.78) was no longer worse than chance, $t(17) = -.89$, *n.s.* In Study 5 (Cognitive psychology students) still performed at a rate worse than chance .72, $t(46) = -2.46$, $p < .05$. The effect of the basic intervention (studies 1 & 2 vs. 4 & 5) was *n.s*. The effect of the additional information in study 5 was also *n.s*.

Conclusion

In the exploratory studies pilots and cognitive psychology students favoured a confirmatory approach to reorientation, but, interestingly, orienteers favoured a disconfirmatory approach. In the intervention studies we found no evidence that either pilots or cognitive psychology students benefited from a short lecture in which the problems of a confirmatory approach were described (although we noted that pilots no longer performed worse than chance).

It is recommended that the effect of confirmation bias in pilot lost procedures should be taught to all student pilots. Not least, that if pilots are going to use a confirmatory strategy they need to be encouraged to find landmarks which are unique to a location. However, if this can't be accomplished (it often cannot) then pilots need to adopt a disconfirmatory strategy. We suspect that the tendency to use confirmatory evidence will be difficult to overcome as it may appear to be highly plausible.

Future research could interview orienteers in depth to find out why they use the strategy they use.

Knowledge Management in Air Navigation Service Organisations: The Case of Airways New Zealand

by
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Abstract

There is a growing interest in organisation knowledge management and significantly its recognition as a major organisation resource. To date organisation knowledge management has been applied mainly to businesses in the development of a competitive advantage for profit maximisation. Companies have become increasingly aware of the value of managing their knowledge base and extensive research has focused on the processes of organisational knowledge management (Foil & Lyles, 1985). However, not all organisations have profit as their sole or primary organisational goal. The linking of knowledge management to the achievement of non-financial goals of organisations is at best very limited. This paper extends the knowledge management literature to aviation, in particular organisation knowledge management in air traffic control organisations. The knowledge management system of Airways New Zealand (Airways), the Air Navigation Service Provider within New Zealand and much of the South Pacific, is analysed to illustrate the application of organisation knowledge management to safety in aviation. As a safety critical organisation, Airways manages its knowledge to improve aviation safety. Airways provides access to the knowledge in its manuals, operations procedures, instructions and routines to the operational staff (air traffic controllers and air traffic services support staff) during ab-initio training, up-grade training when a new qualification is being sought, regular ongoing cyclical training, publication of new orders and instructions as change occurs and interaction between individual controllers. Therefore in effect there are two repositories of Airways' knowledge; the written knowledge contained within the manuals and instructions, and that less tangible knowledge which the staff hold in their memory. The paper describes the knowledge management process and its complexities in Airways New Zealand as a case study of air navigation organisations.

PATTERNS OF THREAT AND ERROR MANAGEMENT IN REGIONAL AIRLINES

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Research involved in this paper is supported by a grant from the
Civil Aviation Safety Authority of Australia

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Abstract

Airlines have traditionally relied upon accident and incident investigation reports to further their understanding of safety and crew performance. However, these reports only capture rare and dramatic events and, whilst sometimes discovering systemic shortcomings, are only useful in a proactive sense if the findings are representative of events and behaviours in normal operations.

Whilst causal factors vary, it has been generally accepted in the airline industry for nearly three decades that more than 70% of accidents involve flight crew error. Similarly it is generally accepted that for every accident it is probable that there have been multiple examples of similar circumstances which did not result in an accident but may have been a "near miss". Due to the fallibility of self - reporting and inadequacies in incident reporting requirements, many of these events go unreported.

If normal operations are monitored effectively, it is possible to diagnose crew behaviours and develop proactive safety interventions. Thus, airlines may be assisted in discovering how close they are to the edge of the safety envelope, without breaching that envelope.

The University of Texas and the LOSA Collaborative have developed techniques for auditing normal airline operations using the taxonomy of Threat and Error Management (TEM) through a project called the Line Operations Safety Audit (LOSA). The project has studied major carriers and established a database (the LOSA Archive) which aggregates crew TEM performance against a series of accepted metrics. (1).

The International Civil Aviation Organisation (ICAO) has endorsed the LOSA methodology as a recommended practice for monitoring normal operations in airlines through the publication of ICAO Document 9803. (2)

Worldwide year on year accident data from the International Air Transport Association indicate that accident rates are significantly higher in regional airlines than in major carriers. (3).

This new research project uses established methodology to study patterns of Threat and Error Management in regional airlines and compares them with the data for major carriers contained in the LOSA Archive. It is supported by a grant from the Civil Aviation Authority of Australia.

Threat and Error Management

The framework of the Threat and Error Management (TEM) model is shown in Figure 1. It conceptualises operational activity as a series of ongoing threats and errors that flight crews must manage to maintain adequate safety margins. Threats are external events or errors by other parties, outside the influence of the flight crew, that increase the operational complexity of a flight and require management by the crew in order to maintain safety margins. Complex, challenging and distracting operating environments increase crew workload and increase the likelihood of error.

Crew errors can vary from minor slips and lapses, to more severe errors of omission or commission with outcomes that adversely affect safety. Regardless of cause or severity, the outcome of an error depends on whether the crew detects and manages the error before it leads to an unsafe outcome. The foundation of TEM lies in understanding error management rather than solely focusing on error commission.

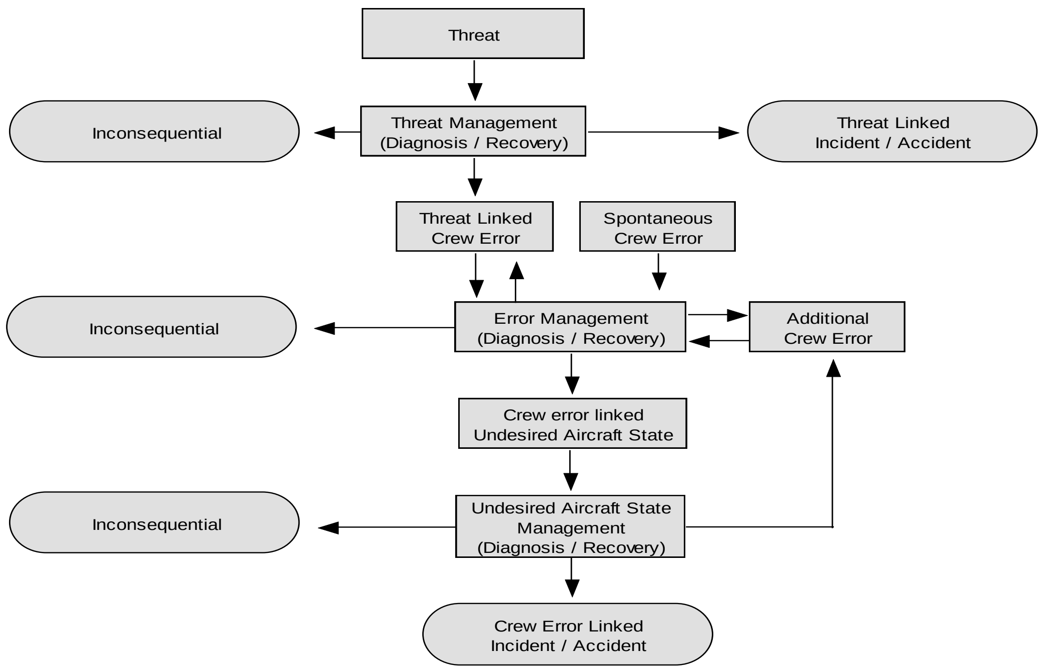

Figure1. THREAT AND ERROR MANAGEMENT MODEL

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It should be noted that not all errors are produced by threats. Experience has shown that only approximately 50% of errors are directly linked to a threat and that the remaining 50% of spontaneous errors are a direct example of the frailty of human performance. It is this very frailty that underscores the vital need for robust procedures and discipline both to minimize occurrence and to detect and manage errors prior to them becoming consequential.

Current Research Project

Normal Operations research to date has concentrated on major carriers flying jet aircraft. However, accident data from the International Air Transport Association (IATA) shown in Figure 2 illustrates that regional airlines flying Western - built turbo - prop type aircraft are more than twice as likely to be involved in an accident as aircraft from major carriers based on sectors flown and almost five times more likely based on hours flown. Research from multiple sources also reveals that in excess of 70% of all airline accidents involve crew – related human factors. This figure is accepted throughout the aviation industry.

Airlines that serve regional and rural centres form a significant part of the aviation landscape in Australia, New Zealand and the South Eastern Asia Pacific region. Accidents and serious incidents occur more frequently in the regional airlines sector of the industry than in the larger carriers using jet aircraft (3).

	Western-built Aircraft		Eastern-built Aircraft	
	Jet	Turboprop	Jet	Turboprop
Hull Losses per million sectors:	0.75	1.62	1.85	26.2
Hull Losses per million hours:	0.39	1.94	0.85	17.5

Figure 2. Extract from IATA Safety Report 2007

The figures for Eastern – built aircraft show even more alarming differences involving a factor of fourteen in sectors flown and over twenty fold based on hours flown (3). However, whilst the number of Eastern - built aircraft in use worldwide increased by 10% in 2007/8, as illustrated in Figure 3 they still only comprise approx 24% of the world turbo – prop fleet and fly less than 10% of the total hours of that fleet (3). Significantly Eastern - built aircraft are all but non – existent in the geographical area of interest and therefore do not specifically form a focus for this project.

	Western-built Aircraft		Eastern-built Aircraft	
	Jet	Turboprop	Jet	Turboprop
World Fleet (end of year)	19723	5563	1617	1744
Hours Flown (millions)	51.14	6.69	1.18	0.63
Sectors (landings) (millions)	26.66	8.04	0.54	0.42

Figure 3. Extract from IATA Safety Report 2007

Internationally only a very small number of individual regional airlines have undertaken exercises in reviewing their normal operations. Invariably, the data gained has been kept confidential within the airline and as such, there is no documented research into patterns of threat or human error in this particular segment of the industry.

The research will comprise:

- A study by observation and survey of regional aircraft operations in selected airlines in Australia and the Australasian region to establish patterns of threats and errors and the effectiveness of their management by flight crews.
- A comparison of the results with benchmark data from the LOSA Archive to examine for differences.

The output of the project will be a research report on the collated data from all participating airlines and an analysis comparing patterns of TEM performance between the regional airlines and the major carriers in the LOSA Archive. Differences may provide the basis for training, operational or regulatory interventions within regional airlines. In addition to the main research outputs each participating airline will receive:

- A comprehensive report analysing the patterns of TEM in that airline
- De-identified raw data and reports from all flights
- Benchmarking of detailed TEM patterns against the LOSA archive

Thus, on an individual basis, participating airlines will have available an objective analysis of crew performance during normal line operations.

The results of the benchmarking exercise will inform further research to develop appropriate intervention strategies to address any issues that become apparent. The areas may include (but are not limited to) training, operational procedures and techniques and regulatory effectiveness.

Conclusion

This project is has been established as a result of the higher rate of accidents and serious incidents in regional airlines flying turbo – prop aircraft when compared to major carriers flying jet aircraft. Accidents and serious incidents in the regional airline sector of the industry far exceed those in larger carriers.

The research will specifically investigate patterns of Threat and Error Management during normal operations by regional airline crews in the Australasian region and compare these with results already held from major carriers. The results will inform and assist the development of training, operational and regulatory interventions with the aim of reducing accident rates amongst regional airline sector of industry. The project builds upon work that has previously been conducted in the major airline sector.

At the time of writing the observation phase in progress and the research is planned to be completed by the end of the second quarter of 2010.

The research uses established LOSA methodology developed by the University of Texas and the LOSA Collaborative (1). This methodology is in the public domain and endorsed and published by ICAO in Document 9803 as a recommended practice for normal operations monitoring.

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Threat and Error Management: An Empirical Analysis of Safety Occurrences in New Zealand General Aviation from 1992 - 2008.

by
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Abstract

This paper uses the Threat and Error Management (TEM) framework to analyse safety occurrences reported to the New Zealand Civil Aviation Authority (NZCAA) for the 1992 to 2008 and included in the NZCAA Database. It provides empirical evidence on the nature and frequency of threats, errors and undesirable aircraft states associated with aviation safety occurrences reported in New Zealand. This study is the first to use TEM to analyse reported safety occurrences and provides information that increases our understanding of aviation safety in New Zealand and can be of help to pilots, airlines and regulatory agencies in their threat and error management and training to increase aviation safety margins. The NZCAA database included a total of 3993 reported safety occurrences (incidents and accidents) within New Zealand's Territorial waters for the study period 1992 to 2008 covering all types of aircraft and activities.

Of the total reported safety occurrences twenty percent (20%) were accidents and eighty percent (80%) incidents. Over this period safety occurrences generally increased from 50 occurrences in 1992 to a peak in 2005 of 480 occurrences but have since fallen to 310 in 2007. The increasing trend in safety occurrences from 1992 to 2005 may partly be due to an increasing positive voluntary reporting environment. The cruise phase of flights involved the highest safety occurrences and pre-flight/taxi and taxi/Park phases the lowest. For all safety occurrences 74% involved errors (31% aircraft handling errors, 29% procedural errors and 14% communication errors) and 26% involved threats (18% environmental threats and 8% airline threats). The most common environmental threats were terrain and traffic under and for airline threats aircraft systems, engines, flight controls and other aircraft were the most frequent. The most common aircraft handling errors included vertical and lateral deviations followed by runway errors and hitting ground based objects. For procedural errors non compliance with SOPs and entering controlled airspace without clearance were the leading errors. The most frequent communication error was missed calls. The undesirable aircraft states with high frequencies include lateral deviations, vertical deviations, loss of separation, being in military/controlled or restricted airspace without clearance and uncontrollable flight. Pilots with less than 300 hours on the aircraft type accounted for about 80% of the safety occurrences. However, for total pilot hours on all aircraft flown by a pilot we find a bipolar frequency distribution. Those with less than 500 hours and those with flight hours of 2,000 or more accounted for over 70% of all safety occurrences. Most safety occurrences happened between the hours of 2200hrs and 0300 hours.

These results suggests that the often used accident rate per number of flight hours as a measure of aviation safety may not be a good measure of air safety in general

since by focussing on actual accidents it excludes all states of air safety margin reductions. In line with TEM's philosophy understanding causes of compromised aviation safety margins can lead to more effective safety management and consequently fewer accidents. Our results suggest that air safety margins in New Zealand may be at historically low levels in contrast to the falling accidents rates per one hundred thousand flight hours reported in the NZCAA 2005 study.

COMMERCIAL ASPECTS OF AVIATION

Airline Strategic Alliances: A Success or Failure?

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Abstract

There has been an explosion in the formation of strategic alliances in the airline industry since the mid 1980s. The nature, forms and extent of airline alliances are extensive and complex with no clear criteria of what a strategic alliance is and what is not. They range from simple marketing agreements, single route cross seat sales, route joint ventures to global alliances such as One World and Star Alliance. A strategic alliance is one of the corporate strategies open to airlines in their quest to gain competitive advantage to ensure profitability, long term viability and ultimately survivability. However, to date it does not appear to be the case that airline strategic alliances have been effective in helping airlines avoids bankruptcy, even for major carriers such as Swiss Air, Air Canada and United Airlines. This paper examines the origin, evolution and development of airline strategic alliances and assesses their success or failure as a major airline business strategy.

Public/private risk-sharing in air service provision*

David Timothy Duval†

July 2009

Abstract

The paper identifies and theorises future trends in public/private risk-sharing agreements, as a form of public subsidy, in thin market air service provision. Using a Pacific Islands example, and building on a precedent from the West Indies ten years prior, the paper details the economic and policy implications of such agreements. In November 2008, the Cook Islands (CI) reached a risk-sharing agreement (with a reported value of NZ$5 million) with Air New Zealand that secured the continuation of a weekly flight from LAX to RAR. By buying the option directly from the producer, the Government has secured access via public subsidy to ensure future visitation. Supply-side subsidisation of air service provision is not uncommon. Existing models such as the U.S. Essential Air Services scheme and the Australian Remote Air Services Subsidy Scheme demonstrate the importance of connectivity of destinations for overall economic growth. The paper makes use of policy analysis to dissect the stated value of securing air access on the part several Pacific Island nations, including the Cook Islands, Samoa and Tonga. The paper concludes by assessing future trends of direct government subsidisation of air services for autochthonous destinations given increasing stress on airline unit costs.

*Thanks to Professor Robin Grieves and Professor Timothy Crack, for permission to build on earlier joint discussions, and John Dean, CEO of the Cook Islands Tourism Corporation. This paper sits currently as draft, and thus any and all errors of fact or interpretation rest solely with the author.

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The Externalisation of Air Transport Reform in Europe: a Selective Analysis of the Developing Role of the European Commission

Alan Williams

Abstract

The final stages of the development of the of the European single air transport market which took place between 1993 to 1997, saw the parallel emergence of a significant number of bilateral service agreements (ASAs), between the United States as prime mover, and individual member countries of the EU. These ran counter to the general thrust of the EU strategy for air transport liberalisation, because they effectively endorsed the right of member states to retain their traditional status in the matter of third country negotiations as defined by the Chicago Convention of 1944. This resulted in considerable internal conflict between the member states and the European Commission

As a consequence the EC took a case to the European Court of Justice (ECJ), which ruled in its favour in the matters brought before it. The final judgement not only led to the validation of the EC's role as prime agent in international aviation development. It also saw the introduction of a comprehensive programme of ASA modifications utilizing horizontal bilateral agreements. In addition the EU proceeded to expand the role and scope of its externalisation programme, which now includes an expansion of negotiated agreements with states outside the geographical boundaries of the EU.

Current developments have also seen the introduction of negotiations for what are now being termed comprehensive bilateral agreements, with China, the United States as well as with Australia and New Zealand. This paper will examine the course of events leading up to the endorsement of the rights of the EU to negotiate all formal agreements with third party countries both individually and collectively as well as the subsequent and current strategic directions taken by its expanding externalisation strategy. It will also treat the New Zealand negotiations post 2005, as an operational case study

Introduction

There can be no evidential doubt that international air transport has had a major influence on the processes of industrial expansion (Grancray, 2009) that have driven international business on a global scale over the last thirty years. This is seen in the various ways in which the international movement of passengers, cargo and other services have grown exponentially prior to the current economic crisis. In the case of air cargo, the growth of express services by specialist carriers now accounts for approximately 40% of the high-value low cost air services market. The development of aircraft technology as a further example has opened up an increasing range of non-stop travel services on inter-continental services, in which those business executives, whose scale of responsibilities have grown to cover multi country locations, over increasing physical distances can travel in personalised comfort.

Such developments fit with the major changes that are reshaping not only international business but also the very nature of their national identities. As international markets grow and the logistics of supply chain management becomes more complex, the classic home country headquarters of multinational firms is increasingly giving way (Desai, 2008) to various forms of corporate mutations. The classical models of an international corporation trading across national boundaries from its traditional home base, where formal incorporation and the prescribed national identity of the investor base are located, are now an endangered species. Today even the brand name of a global firm may have minimal linkages with the country of origin, as companies merge, amalgamate, and experience take-overs, form alliances with market rivals or search for new international investors and new locations for production.

It is at this point when attention is turned to the contributive roles of the air transport system that a strong element of paradox enters any discussion. While the global aircraft manufacturers are well up to speed with their emerging roles as international system integrators covering all aspect of their business from conception to roll out. By contrast airlines as the core sector have tended to be somewhat proscribed in their moves toward international market liberalisation, by the continued presence of the Chicago Convention of 1944. As a consequence there remains a significant proportion of ASAs in which duopolistic market arrangements offer limited access to sovereign air space by designated national carriers.

There can be no doubt that the continuing regulative limitations imposed by this traditional system have contributed to the disappointing performance of many major legacy carriers who tend to consistently return low or minus profits in a high demand industry. In the American case there has also been evidence of a rising trend toward larger but fewer airlines, which consistently raises the question of potential anti-trust problems for the authorities. It has been suggested by a recent study (Hsu and Chang,2005) that such domestic problems encouraged US government support for the development during the 1990s of a significant number bilateral agreements with the member states of the European Union.

The authors went on to suggest that throughout the extended period required for the development of the single European air transport market. The United States had a vested interest in the traditional status quo, since a unified single market would lead to cabotage restrictions on common 5th freedom rights with the signatory member states. From the member state perspective, unification would in turn, lead to challenges to the anti-trust immunity that was built in to what the United States perceived to be their own version of open skies. (5) It appears that the fact that under the American open skies arrangement the domestic market in America remained closed to European traffic did not detract from the hostility that was shown to the EU initiative by some of its key member states. On three separate occasions they refused support a mandate endorsing the power of the EU to handle all future negotiations with foreign countries.

From a strategic perspective the EC decision to go to law in the matter of the limitations imposed by the terms of the existing ASAs, appears to have been based on two problematic perceptions. The first involved the fragmentation effects on single market unification imposed by what might be termed the continuing presence of the US-member state agreements. The second raised the fundamental issue of the supranational authority of community law. How far the EU claim before the European Court of Justice carried the day on each of these issues will now be considered below.

The Ratification of the Supra-power of Community Law in the making of International Air Service Agreements

<u>The Formal Emergence of the European Single Air Transport Market</u>

During the decade that was to see the emergence of a single aviation market in Europe. The European Commission utilized a sequential three stage approach to this key project development through the introduction and endorsement and specific packages of legal and regulative requirements
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1. *The first package introduced in 1987, allowed the government of member states limited rights to object to the introduction of new fares on routes involving intra-EU traffic. Airlines were also granted increased flexibility in the matter of seat sharing between airlines.*

2. *This was followed in 1990, with the extension of the flexibility rule in fare setting and seat sharing. In addition the EU carriers were granted the right to carry an unlimited number of passengers or cargo, between their home countries and another member state.*

3. *The final package came into operation between 1993 and 1997 and provided cabotage as well as the harmonisation of the requirements for operational licenses for EU airlines. This in turn allowed open access by carriers to all routes and imposed on member governments, public sector obligations on those routes considered to be essential for regional development. Full freedom was also granted to airlines, enabling them to set fares and rates, with the decision*

to rescind the need to make submissions to their national authorities for permission to do so.

The strategic direction taken by the EU is reflective in the macro sense according to a leading British scholar (Lawton, 1999), of the processes of the transfer of a degree of political power from the individual member states to the EU in Brussels. On the other hand that same degree of power conceded by the member states does not constitute in law the transfer of total authority. What has been referred to by scholars as the process of Europeanization, is in essence a dynamic and sometime acrimonious balance of authority between supranationalism in Brussels and various forms of national institutionalism to be found across the various member states.

Figure1. The Essential Distinction between Supranational and National Authority.

<u>**European Commission**</u>**: Now** has growing supranational authority to shape and control EU policies through legal and regulative processes. Currently seeking to expand air transport agreements to cover to non-member states outside the designated boundaries of the EU
<u>**Member States**</u>: **Retains** popular legitimacy as well as managerial control over national institutions. European policy is now determined by an interactive process between the national and the supranational levels of authority. It is also subject to an increasing stress on policy objectives that are reflective of a growing emphasis upon external and even global developments.

Adapted from: Lawton, T.C. (1999) Journal of Public Policy p.94. (6)

It is clear from a geopolitical perspective that the issues that arose of over the question of bilateral air agreements posed serious questions of autonomy for the emergent single aviation market. Attendant upon the notion of a single market was the larger question of the redefinition of the various European airlines as Community carriers a proposal that ran counter to the basic principle of the national sovereignty of state owned carriers. At the strategic core however we find (Dymond and de Mestral, 2003) that the EU as a logical corollary to the establishment of the single market now wished to extend its mandate to include the negotiation of all international air service agreements with foreign states.

As earlier discussion indicated some three attempts to advance the case for this further mandate within the context of formal discussions with member states failed to gain legal traction. Instead the EC found itself facing a serious determination to retain national jurisdiction over ASAs as defined in the Chicago Convention. As a final response to this stand-off, the decision was taken to test the legal parameters of EU authority, with a formal action taken before the European Court of Justice.

The Arguments Presented before the ECJ, prior to the Landmark Ruling.

The Legal Arguments Presented by the EC

The decision of the EU to go to law took the form of a challenge with regard to the autonomous legal rights of some ten member states to create open skies ASAs with the United States. The principal arguments which aimed to test the legality of such agreements were founded on three linked assertions.

1. *That the traditional provisions on national ownership and control of designated airlines as duly designated in each specific bilateral agreement , violated the principle of freedom of establishment of persons and corporations as established by Article 43 of the European Community Treaty.*

2. *That by virtue of their adoption of the extensive EC legislation government air transport; member states had relinquished their authority to negotiate independent agreements with foreign states.*

3. *That bilateral agreements made in the interests of individual member states potentially violate the principles of EU competition law and upset the freedom to provide services across national borders throughout the Community, particularly with respect to air fares on intra-Community routes, computerised reservation systems and the allocation of airport slots.*

The Decision of the ECJ Promulgated on 5 November 2002

It became immediately clear after the Court published its decision that while some key matters were settled in favour of the EU, others were still open to further consideration. In the matter of bilateral agreements the ECJ found that some seven member states were in violation of some aspects of primary treaty law as well as the secondary legislation cited. In addition the Court found retrospectively, that a further1500 existing agreements signed with foreign countries other than the United States were in violation, including some thirteen countries which were making formal application for EU membership.

The Court also found that the national ownership and control requirements in the ten bilaterals cited in the EU brief actually violated a central principle of the European Treaty itself. The causal factor was found to be located in the designation process, where the nominated carriers were either owned or controlled by the signatory member states. This procedure the Court found had a serious negative effect in law, because it denied the rights of airlines in other member states to receive any form of national treatment after the ASA was duly signed and sealed.

Finally, the ECJ was unequivocal in its support of the legal assumption, that to the extent that member states had handed over the internal jurisdiction of control which was now vested in the EC, such managerial powers was extended in principle beyond the domestic and into the external international market. It is important to be aware at this juncture, that the ECJ did not then proceed to further define and reform the actual range of powers, beyond matters specified in original brief relating to fares, reservations and airport slots. In fact later when it introduced the model requirements for the new horizontal agreements, the Air Transport Directorate, was at pains to advise all parties of the following restrictions on the form that such agreements should take

Limitations on the Role and Scope of Horizontal Bilateral Agreements

1. *They were not traditional ASAs, since they did not deal with traffic rights and attendant terms and conditions.*

2. *They were not comprehensive air transport agreements.*

3. *They did not possess multilateral terms and conditions.*

4. *Their primary function was not to replace but amend existing agreements between EU member states and third countries.*

Adapted from: The Model Horizontal Agreement/ EU Directorate-General Energy and Transport/Air Transport Directorate-2006

As a consequence the powers of the mandate to negotiate internationally are still in the legal sense, relatively limited. On the other hand the EC was given the legal obligation to negotiate at least fifth and possibly seventh freedom rights for all carriers operated by member states, as a part of the emergent need to restructure existing ASAs in line with the ECJ's ruling. In addition the exclusive EU competence in matters relating to international aviation agreements was confirmed by the mandate the EC then received from the EU Transport Council in June 2003.

The Formal Activation of the EU Mandate

Defining a horizontal agreement

In order to examine the implications of the ECJ decision it is first necessary to offer a definition as to the role and purpose of the new horizontal bilateral agreements. The official designation follows.

A horizontal agreement is negotiated by the EC on behalf of the member states, in order to bring all existing bilateral air service agreements between member states and a given third party country into line with EU law.

The purpose of the horizontal agreements is clearly intended to amend the nationality clauses in existing ASAs so that they no longer discriminate against other member states under Community law. It also places responsibility for all further re-negotiations with the EC. Following the formal endorsement of the new mandate at the June meeting of the Transport Council of the Commission in 2003, already noted above, decisions were then made as to the methods to be deployed in the activation of a formal amendment strategy.

The Council meeting identified two possible approaches to the amendment process. Either to treat all negotiations between a member state and its third party partner as a series of single autonomous activities to be settled in sequence over the medium to long term or, to adopt what might be termed a template approach, as offered by the specific terms in the horizontal agreement format.This would allow for a form of standard clause modifications which would be transferable between a whole series of agreements.

The relative efficiency of the horizontal agreement method is reflected in the fact that in application one such agreement can lead to the modification of up to twenty seven bilateral agreements at a time. This is reflected in the distribution of completed requirement between 2003 and 2008, which is revealed in the following table.

Table 1. The Distribution of Completed New Agreements: 2003-2008

Methods Deployed	**Number States**	**Number of Completed Agreements**
1. Case by Case ASA	60	132
2. Horizontal ASA	37 + 8*	651
Total	105	783

Adapted from: European Union Document IP/08/1609, European Commission, Brussels
Note: The additional 8 third party states listed in the horizontal agreement category were members of a regional agreement covering all member airlines.

The Strategic Emergence of Comprehensive Air Transport Agreements

The ongoing expansion of horizontal agreements to adjacent regions and countries is no longer restricted by physical location, since for example. both New Zealand and Australia are covered by the terms of the horizontal agreements initially applied to European signatories to the original open skies arrangements with the United States. It is now time to turn attention to the larger substantive contexts that inform international dialogues between the EU the United States and China, as well as an increasing number of smaller states on an increasingly global basis. The search for Comprehensive Air Transport Agreements has taken on major new dimensions which replicate to some degree the normative intentions contained in free trade agreements.

Even an outline of the complexities of the EU relationship with China, would require a paper of its own, especially since that country has been the focus of both material aid and significant foreign direct investment by member states. As a consequence the ongoing negotiations with the United States, will serve here as a working case example. It will also illustrate the manifest problems that often underpin the dynamics of sustained and protracted negotiations over time.

The Continuing Complexities of EU-US Air Transport Negotiations

The European Union has for some time been engaged in the formal negotiation of comprehensive Air Transport Agreements with notably, China and the United States.
In March 2007, the United States and the EU implemented (Goldman, 2009) a new form of open skies agreement with the EU and its twenty seven member states. (9) Both sides achieved important key objectives The US saw the timely end of the US/UK Bermuda 2 arrangement, which opened Heathrow to all US carriers. In turn the EU obtained the recognition of European carriers as "Community Airlines" that can fly the North Atlantic routes without regard to national identity. It also received 7th freedom rights for airline flying non-stop from the emergent European Common Aviation Area.

What was left on the table at the completion of negotiations was the EU plan for a transatlantic Open Aviation Area, which would cover a single market with reciprocal rules regarding the elimination of limitations on full cabotage, airline ownership and other controls. At this point the Americans rejected further progress, in the language of one official commentator as "a bridge too far". The parties then decided to treat the 2007 agreement as a stage one agreement setting a timetable for second stage talks in 2008 leading on into 2009. It was anticipated that this would run through into 2010, with the proviso that if no agreement was reached then, the provisions already agreed would be suspended and arrangements would revert to pre-2008 conditions.

By May 2008 the positive developments of the previous year started to unravel. While the new arrangement called for the restriction on EU carriers investing an equity majority in American airlines had been lifted, the US Congress insisted that the essential voting rights that came with the purchase should still remain at 25%. On the other hand a US carrier taking a controlling interest in a European counterpart would receive 49% of the voting rights. This is a highly contentious issue since US airlines are not a good investment risk, given their increasingly frequent residence in Chapter 11 bankruptcy.

A second order problem related to market access on either side of the Atlantic can be found in the fact that while an EU carrier could fly under the agreement to any city in the United States, subject to airport service and slot availability, the domestic market remained closed. By contrast an American airline could fly to London, pick up passengers and continue on to Rome, Paris, of Frankfurt. While these problems were sufficient to create tremors, the primary forces of political change began to do their work with the election of a New US President in November 2008.

Despite popular expectations the election of President Obama, provided an unexpected new problem for the parties. This occurred because in the run up to the election the incoming President had responded to an ALPA candidate's questionnaire. As a consistent pro-worker candidate Obama stated that he was firmly opposed to changes in the US cabotage laws as well as any plans to change the ownership and control of American airlines. The impact of the President's views are yet to be reflected in terms of the new agenda for June 2009 which is the date of the scheduled continuance of the second phase of negotiations, and speculation as to the possible contents lies outside the role and scope of this paper. Discussion will return however after due consideration of the plans for the territorial expansion of an EU aviation relationship, with neighbouring states in South eastern Europe.

The Game Plan for External Expansion by other Means

The decision by the EU to follow what has been called a systematic roadmap for the development of external air transport markets appears to be based on three macro agendas as listed below.

1. *Ensuring the legal certainty of existing bilateral agreements between EU member states and third countries. This guarantees the necessary continuity of air services as well as a stable operational environment.*

2. *Developing a common civil aviation area with regional neighbouring states, by 2010.*

3. *Negotiation of comprehensive air transport agreements at the EU level with certain third countries. Such agreements go far beyond the scope of traditional ASAs. The aim of these agreements is to create new economic opportunities for the European air transport industry and to ensure fair competition through a process of regulatory convergence.*

Earlier discussion has introduced the question of the externalisation of the EUs role in international negotiations with foreign countries. The balance of the paper will look first at the second agenda which relates to the formation and development of the ECAA. It will then return to the consideration the third issue of comprehensive air transport agreements, already raised with the US example above. It will also utilize current developments with New Zealand as a smaller country case example.

The Expected Role and Scope of the European Common Aviation Area

A further strategic goal of the European Commission, in its quest for control over the process of international negotiations with foreign states, is revealed in the fact that in June 2006 an agreement was signed between a group of south east European countries and the EU, which brought into being plans to create a European Common Aviation Area by 2010. The developmental programme calls for the various member states of the western Balkans, joined by Iceland and Norway to eventually become a single market for aviation which will comprise some 35 countries and 500 million citizens.

Figure 2. The Specified Balkan States

- Albania
- Bosnia and Herzegovina
- Croatia
- Macedonia
- Montenegro

- Serbia
- Kosovo

Adapted from: D. Muller –Jensch, EC-WB Air Transport Report for South East Europe, 2007. p.2

The ambitious plan calls for the Balkan states to adopt the EU "Acquis commautaire" (all aspects of law rules and practice currently followed by the EU aviation industry). The following selection of formal requirements is indicative of the need for all the new member states to be in compliance with EU codes of practice. The scheduled development programme also requires that all the new states in the ECAA will have met the technical standards as specified in EU internal market practice by the year 2010.

Figure 3. Selected Compliance Standards for States entering the ECAA (12)

- Legislation that liberalises market access, traffic rights and fares
- Regulations on airport ground handling and slot allocation.
- Safety and Security regulations
- Rules on competition and state aid
- The acquis related to air traffic management and the Single European Sky
- Environmental standards and consumer rights pertaining to aviation.

Adapted from: D. Muller-Jentsch, 2007, op. cit. p. 4.

Given the operational timetable for all the pre-requisite arrangements for member state integration into the ECAA by 2010, the various countries involved face an extremely heavy schedule. As is common in most economically emergent regions, the various states are at often quite different stages of market growth, especially in their domestic sectors. As an example the most successful of the current operators who have signed up to join the new open area, is Croatian Airlines with a fleet of eleven aircraft. In addition while Zagreb and Belgrade are the main regional airports and both are quite small by European standards. It must also be observed that the region itself is without a central gateway hub. With these limitations in mind, the future growth rate of the new ECAA remains currently uncertain, especially in the current international economic climate.

The Comprehensive Aviation Agreement: New Zealand as a Case in Progress

The balance of the paper will focus upon the immediate effects of the substantive changes in ASA commitment reported between 2003 and 2008 using New Zealand as a case example. It is important to note at this juncture that major changes began in 2005 when the modifications required under the horizontal agreement mandate were moved into the South Pacific and were formally signed off between Brussels and Wellington.

The Emergent Comprehensive Aviation Agreement

In September 2007, the EU and New Zealand signed a joint declaration of intention with regard to future Relations and Cooperation. The document was based on earlier negotiations with New Zealand in 1999 and 2004, which signalled a common interest by the parties in the extension of diplomatic, social, economic and trade relations. While New Zealand's role as a progressive country in matters relating to the expansion of liberalisation in air transport. The role of air services was restricted to Article 44, where after welcoming the 2005, horizontal ASA, the parties committed themselves to new negotiations for a Comprehensive Air Services Agreement.

The Declaration also called for progress in the implementation of the actions that had been identified by the Participants. It also noted that a comprehensive review of practical steps to maintain close consultation and cooperation, will be scheduled for 2012 It remains to note that on 25 November 2008, negotiations commenced in Brussels and that officials there anticipated swift negotiations with positive results for both sides. Finally it is anticipated that the progression of negotiation as could see New Zealand set benchmarks for air transport agreements on a worldwide basis, with broad spectrum benefits for all.

Conclusion

This paper is essentially a first attempt to isolate and examine the various strategic intentions that have driven air transport reform as a primary geopolitical policy in Europe, since the emergence of the single aviation market in 1997. What has followed has been a period in which the essential tension between the European Commission as a supranational authority and the member states as national entities, was somewhat exacerbated. The primary cause as reflected in the paper's narrative was the decision of the EC to seek under mandate, strategic power and control over all future negotiations with third party countries in all matters relating to air transport agreements.

While the evidence may be described as a series of snapshots of high complex geopolitical issues, it is clear that the emergence of Comprehensive Aviation Agreements is also reflective of much larger macro objectives. These tend to become formal situations in which air transport agreements tend to be subsumed within a larger agenda which includes, diplomatic, economic, social and political objectives to be achieved over time.

A further important development discussed in the paper reflecting an ongoing policy duality is reflected in the notable development of the European Common Aviation Area agreement, which is in real sense the obverse side of the proposal for a Transatlantic open skies agreement. It is worthy of note at this point that the physical parameters of the European Union now extend to twenty seven member states. It is also important to observe that the EC is also in dialogue with Ukraine, Morocco, the Russian Federation and India.

In the case of New Zealand any attempt to anticipate the outcome of negotiations with the EU would be totally speculative at this point in time. It would be timely however if consideration were given to the possible geopolitical study of all current agreements, for example with China, and potentially with the proposed ASEAN single aviation market which is due for launch by 2015. Where the future EU-NZ-CAA will fit would be an interesting focus for further examination.

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